Class I & A Exam

Choose the best answer

True or False

1. Floatable solids are easy to measure.
   a. True
   b. False

2. A well-operated digester normally receives sludge at about __________ % volatile solid and reduces it to about __________ % volatile solids.
   a. 70-75%, 25-30%
   b. 90-95%, 45-50%
   c. 90-95%, 25-30%
   d. 70-75%, 40-45%

3. According to OSHA, which of the following oxygen in air concentration is the lowest safe concentration for humans to breathe in order to avoid the hazard of oxygen deficiency?
   a. 7.5% oxygen
   b. 19.5% oxygen
   c. 21% oxygen
   d. 33% oxygen

4. The population equivalent factor for BOD is
   a. 0.15 lb/day/BOD/person
   b. 0.17 lb/day/BOD/person
   c. 0.20 lb/day/BOD/person
   d. 0.22 lb/day/BOD/person

5. Which of the following groups of microorganisms are found in a good settling mixed liquor?
   a. Rotifers, stalked ciliates and free swimming ciliates
   b. Flagellates, free swimming ciliates and stalked ciliates
   c. Stalked ciliates, rotifers and flagellates
   d. Nematodes, flagellates and stalked ciliates
6. Which heavy metal is the most stringent for land application?
   a. Copper
   b. Zinc
   c. Lead
   d. Mercury

7. Grit chambers that are designed to remove grit have a velocity of
   a. Less than 0.5 ft/sec
   b. 0.5 to 1.0 ft/sec
   c. 1.5 to 4.0 ft/sec
   d. 2.0 to 4.0 ft/sec

8. The purpose of adding sodium thiosulfate to a microbiological (such as fecal coliform) sample bottle is to
   a. Extend the allowable holding time from 6 to 30 hours
   b. React with nitrates that interfere with the MPN test
   c. Remove any chlorine residual present
   d. To insure sterilization of sample bottle

9. Which of the following types of wastewater would settling occur most rapidly?
   a. Cold wastewater
   b. Old wastewater
   c. Septic wastewater
   d. Strong wastewater

10. The disadvantage of using a constant percentage return activated sludge flow control is
    a. Variations in the MLSS concentration are reduced
    b. F/M varies more than with constant rate RAS control
    c. MLSS remains in the clarifier to long
    d. Clarifier is subjected to maximum solids loading when it contains maximum amount of sludge

11. Under which one of the following conditions should sludge wasting normally be increased?
    a. Mixed liquor settles to slowly
    b. Large pillows of white foam start forming on the aeration tank surface
    c. A dark brown scummy foam appears on the aeration tank surface
    d. All of the above
12. The outlet of a forced ventilation system for a chlorinator room should be located
   a. On the roof
   b. Above the window
   c. Near the floor
   d. At the same level with the blower

13. If packing is not maintained properly
   a. Cavitation damage will result
   b. Impeller will corrode
   c. There will be a loss of suction from air being allowed to enter the pipe
   d. Shaft or shaft sleeve will be damaged

14. Turbidity in wastewater is caused by:
   a. Color
   b. Dissolved calcium
   c. Finely divided suspended material
   d. Hardness

15. One of the primary reasons why air should be excluded from the digester is that
   a. Gas storage capacity is reduced
   b. The entrance of air mixed with gas produced in the digester could create an explosive mixture
   c. It interferes with the action of aerobic bacteria
   d. Harmful bacteria may be brought in with air

16. Barminutors and comminutors are installed for different purposes.
   a. True
   b. False

17. What are the end products of the aerobic biochemical reaction?
   a. $\text{H}_2\text{O}$ and $\text{CO}_2$
   b. $\text{H}_2\text{O}$ and $\text{CH}_4$
   c. $\text{CH}_4$ and $\text{CO}_2$
   d. Organic acids
18. Pump maintenance includes:
   a. Checking operating temperatures of bearings
   b. Checking packing glands
   c. Lubricating the impeller
   d. All of the above

19. Pump packing should be:
   a. Changed every week
   b. Tightened down to a drip
   c. Greased when smoke is detected
   d. Tightened to where there is no leakage

20. The fusible plug that is in all chlorine cylinders:
   a. Should be removed after the cylinder is emptied
   b. May be used as a top for the chlorine source
   c. Is used as an electrical connection for evaporating coils
   d. Should never be removed or tampered with

21. A piston or diaphragm pump would be used for pumping
   a. Primary sludge
   b. Raw wastewater
   c. Final effluent
   d. Activated sludge

22. Collection system variables that could upset an activated sludge process include
   a. Activities of collection system maintenance crew
   b. Chlorination of return sludge flow
   c. Recycling a digester supernatant
   d. Decrease in influent flow

23. What type of pump is not seriously damaged if the discharge valve is closed for a short time, while the pump is running?
   a. Centrifugal pump
   b. Diaphragm pump
   c. Piston pump
   d. Plunger pump
24. Which of the following chemicals would be the most effective in achieving a pH adjustment of 8.4 so nitrification can take place in an RBC?
   a. Sulfuric acid
   b. Sodium hydroxide
   c. Soda ash
   d. None of the above

25. Acids should never be added to chlorine solutions because they:
   a. Cause chlorine gas to be released
   b. Corrode or eat away the solution tank
   c. Decrease the disinfection properties of chlorine
   d. Result in the formation of a chloride precipitate

26. Which of the following is a method for treating flow to the primary settling tank that would increase grease removal efficiency of that unit?
   a. Lower the pH to less than 7
   b. Increase the temperature of the wastewater
   c. Add activated silica
   d. Preaerate

27. Three water borne diseases are:
   a. Mumps, measles, cold
   b. Scarlet fever, Pneumonia, hay fever
   c. Typhoid fever, dysentery, cholera
   d. Tuberculosis, diphtheria, chickenpox

28. When organic wastes are discharged to receiving water, oxygen is depleted by
   a. Algae during the day
   b. Bacteria
   c. Ducks
   d. Limestone rocks

29. Sludge wasting from secondary clarifiers, are normally required in order to control
   a. Effluent BOD.
   b. Effluent suspended solids.
   c. Aerator mixed liquor solids.
   d. Sludge settleability.
30. An application for renewal of an NPDES permit must be submitted ______ days before the previous permit expires.

   a. 30  
   b. 60  
   c. 90  
   d. 180

31. From a public health standpoint, which of the following is the safest sludge for soil conditioning purposes?

   a. Sludge dewatered on sand filters or vacuum filters  
   b. Liquid raw sludge  
   c. Heat dried sludge  
   d. Liquid digested sludge

32. The major purpose of an inlet baffle in a settling tank is to

   a. Reduce velocity and disperse flow  
   b. Increase velocity to prevent excessive settling near the inlet  
   c. Remove scum from the wastewater  
   d. Protect the scraping mechanism from damage by excessive velocities

33. The primary purpose of forced draft ventilation in lift stations is to

   a. Prevent odors  
   b. Remove dangerous gases  
   c. Cool the pumps  
   d. Keep the pressure equalized

34. High-rate anaerobic digestion refers to the fact that the organic waste material is applied to an anaerobic reactor at high _________ loading rates.

   a. Gravimetric  
   b. Hydraulic  
   c. Organic  
   d. Volumetric

35. As a digester approaches "sour" conditions:

   a. Alkalinity of solids decreases  
   b. Concentration of volatile acids increases  
   c. Amount of methane production decreases  
   d. All of the above
36. The concentration of volatile solids in the feed sludge to a digester is an indirect measure of the
a. Amount of the sample that will evaporate when standing
b. "Food" available for bacteria in the digester
c. Number of bacteria in the digester
d. Primary effluent suspended solids

37. Typical detention time in a mesophilic digester is:
   a. 5 days
   b. 15 days
   c. 28 days
   d. 120 days

38. The presence of white pillowing foam on an aeration tank indicates
   a. The aeration tank is underloaded organically
   b. The aeration tank is overloaded organically
   c. The aeration tank is overloaded hydraulically
   d. None of the above

39. The chemicals that are added to distilled water for the BOD test serve what purpose?
   a. Assure the presence of DO at all times
   b. Increase thermal conductivity of the solution
   c. Adjust the pH within the desirable range and provide essential elements for the growth of the biological life actually exerting the oxygen demand
   d. Satisfy the natural oxygen demand that might exist in the sample

40. An operator runs a Winkler by the azide modification of the Winkler method. He runs out of standard sodium thiosulfate. Which reagent can be used instead?
   a. Calcium hypochlorite
   b. Phenylarsenine oxide
   c. Sodium bicarbonate
   d. Ferrous ammonium sulfate
41. A identifies what part?
   a. Media
   b. Wash trough
   c. Manifold
   d. Filter floor

42. F identifies what part?
   a. Manifold
   b. Media
   c. Filter tank
   d. Wash trough

43. E identifies what part?
   a. Filter tank
   b. Wash trough
   c. Manifold
   d. Perforated laterals

44. The best way to control excessive foaming during start-up of a digester is to
   a. Add water to the tank.
   b. Allow the digester content to cool slightly.
   c. Increase the feed rate.
   d. Stir gently to release excess gas.

45. The principle function of the zoogleal mass on the trickling filter is to:
   a. Filter the suspended solids.
   b. Reduce the organic content.
   c. Reduce the nitrogenous BOD.
   d. Control the flow to the following processes.
46. Which of the following can cause foaming in the anaerobic digesters?
   a. Nocardia
   b. Fluctuating temperature
   c. Inadequate mixing
   d. All of the above

47. Which of the following sets of characteristics describes a good quality of activated sludge?
   a. Good settling characteristics, some dissolved oxygen present, and brown in color
   b. Brown color, high in ammonia and BOD
   c. Black color, very small particles, which do not settle, and a musty odor
   d. Zero dissolved oxygen content, brown color, and good gas production

48. Ultra Violet Irradiation kills bacteria by:
   a. Heat
   b. Destroying their cellular genetic material
   c. Inhibiting their enzymatic system thus starving the bacteria
   d. Splitting the cell in half

49. Possible techniques for controlling filamentous organisms in an activated sludge process include:
   a. Dosage of return sludge with oxidants such as hydrogen peroxide or chlorine
   b. Lower DO levels in aeration bans so filamentous organisms can not breathe or respire
   c. Lower F/M level to starve filamentous organisms
   d. Stop wasting to allow activated sludge bugs to gain control

50. Which pump is the best for pumping chemicals?
   a. Positive displacement
   b. Centrifugal
   c. Screw
   d. Air lift

51. Low sulfonator injector vacuum readings could be caused by
   a. Low backpressure
   b. Missing gasket
   c. Low flow of injector water
   d. Wrong orifice
52. A white filamentous growth on the RBC media is indicative of:
   a. High CaC0₃ levels.
   b. High rotation speed and lime addition.
   c. Treatment of creamery wastes.
   d. Sulfur bacteria present.

53. The temperature versus DO relationship is
   a. The higher the temperature then the higher the DO
   b. The lower the temperature then the higher the DO
   c. There is no relationship between DO and temperature
   d. The lower the temperature then the lower the DO

54. An increasing F/M ratio and decreasing MCRT indicates
   a. Excessive solids wasting causing a decrease in solids inventory
   b. Inadequate solids wasting causing an increase in the solids inventory
   c. Decreased hydraulic load increasing the sludge detention time
   d. Operation is normal

55. Bar racks and bar screens have clear spacing respectively of
   a. 0.25 to 2.0 inches and 2.0 to 4.0 inches
   b. 0.2 to 1.0 inches and 1.0 to 2.0 inches
   c. 2.0 to 4.0 inches and 0.25 to 2.0 inches
   d. 1.0 to 2.0 inches and 0.2 to 1.0 inches

56. On a large scale which is the best method for removing ammonia nitrogen from wastewater?
   a. Trickling filter
   b. Activated sludge
   c. Breakpoint chlorination
   d. Ion exchange

57. An increase in plant effluent coliform level could be caused by
   a. Short circuiting in contact chamber
   b. A decrease in effluent BOD
   c. High chlorine residual
   d. Lack of solids in contact chamber.
58. **B** identifies what part?

   a. Underdrain system
   b. Media
   c. Distributor arm
   d. Effluent pipe

59. **F** identifies what part?

   a. Influent pipe
   b. Effluent pipe
   c. Ventilation port
   d. Underdrain system

60. **A** identifies what part?

   a. Ventilation port
   b. Media
   c. Underdrain system
   d. Distributor arm

61. **C** identifies what part?

   a. Influent pipe
   b. Effluent pipe
   c. Underdrain system
   d. Ventilation port
62. When collecting a fecal sample, it should be
   a. A grab sample preserved with copper sulfate
   b. A composite sample preserved with copper sulfate
   c. A composite sample without preservative
   d. A composite sample preserved with sodium thiosulfate
   e. A grab sample preserved with sodium thiosulfate

63. The principal difference between step-feed aeration and conventional aeration is that in step-feed aeration the incoming waste load is introduced in slugs at the tank entrance.
   a. True
   b. False

64. The height or energy of water above a point is commonly referred to as the
   a. Flow
   b. Pressure
   c. Distance
   d. Head

65. At what temperature does the muffle furnace have to remain at in the determination of the volatile solids?
   a. 103°C
   b. 500°C
   c. 550°C
   d. 600°C

66. Which of the following factors could cause a demand for more oxygen in an aeration tank?
   a. Increase in pH
   b. Increase in microorganisms
   c. Increase in inert or inorganic wastes
   d. Increase in toxic substances

67. Your maintenance person wants to use general purpose grease in the RBC bearings. The reason for not using general purpose grease is:
   a. It does not contain a high load capability or moisture inhibitor.
   b. The temperature rating is too low.
   c. The color will not show a rusting condition.
   d. The RBC speed is not right for general purpose grease.
68. Which of the following is not an example of a flow-measuring device?
   a. Manometer
   b. Weirs
   c. Parshall flume
   d. Magnetic

69. Why does some of the suspended material in wastewater fail to be removed by setting in 1 hour?
   a. Because it takes 1.5 hours to settle
   b. Because it is lighter than water
   c. Because it’s specific gravity is very close to that of water and it is so small in size
   d. Because it is attached to fine air bubbles

70. The dissolved oxygen concentration should normally ___________ as you proceed through the stages of the RBC system.
   a. Increase
   b. Decrease
   c. Remain the same

71. The most abundant pollutant entering natural water bodies (river, lakes, etc.) is:
   a. Domestic waste
   b. Food processing waste
   c. Non-point source
   d. Hospitals

72. How can a toxic waste be discovered in a treatment plant?
   a. Decrease in aerator DO
   b. Increase in aerator DO
   c. Decrease in secondary effluent floc
   d. Increase in plant inflow

73. Mesophilic range is
   a. 80 to 100°F
   b. 120 to 130°F
   c. 100 to 120°F
   d. 60 to 80°F
74. The most important factor used to determine the number of samples to be collected is the

   a. Discharge limits of waste being monitored
   b. Purpose for the sampling
   c. Flow characteristics of wastestream
   d. Wastewater characteristics

75. Chlorine applied minus __________ equals chlorine residual.

   a. Chlorine dose.
   b. Chlorine demand.
   c. Combined chlorine.
   d. Free chlorine.
   e. Total chlorine.

76. Copper sulfate-sulfamic acid solution is added to a sample of mixed liquor on which a D.O. test is run in order to:

   a. Prevent settling of the sludge while the sample is in transit to the laboratory.
   b. Keep the organic process at a high level while the sample is in transit to the laboratory.
   c. Kill the bacteria which would continue to use oxygen while the sample is in transit to the laboratory.

77. What temperature does the BOD incubator need to be?

   a. 15°C
   b. 25°C
   c. 20°C
   d. 98.6°F

78. BOD is a term that refers to the:

   a. Oxygen demand in milliliters per hour per square meter of lagoon surface during the aerobic phase of metabolism.
   b. Oxygen required to neutralize the effects of anaerobic organisms in wastewater effluents.
   c. Oxygen required to stabilize the decomposable organic matter in a wastewater sample by bacterial action.
   d. Phase of the nitrogen cycle known as anabolism or synthesis.
79. What information must be on a warning tag attached to a switch that has been locked out?
   a. Directions for removing tag
   b. Time to unlock switch
   c. Signature of person who locked out switch and who is authorized to remove tag
   d. Name of nearest physician to call in case of emergency

80. Return activated sludge flow rate may be adjusted or controlled by which of the following?
   a. Food/Microorganism ratio
   b. SVI approach
   c. Mean Cell Residence Time (MCRT)
   d. Sludge Age

81. In order, what are the top three injuries in wastewater?
   a. Face, feet and back
   b. Back, leg and hand
   c. Back, hand and face
   d. Hand, back and leg

82. Ideally, the pH meter should be calibrated
   a. Once a day
   b. Weekly
   c. Twice a month
   d. Before each use

83. Sludge blanket depths may be measured by the use of
   a. Bubbler tubes
   b. Floats connected to cables and pulleys
   c. Ultrasonic transmitters and receivers
   d. A hose and an aspirator

84. The discharge of a centrifugal pump
   a. Decreases with an increase in head
   b. Independent of head
   c. Increases with an increase in head
   d. Is not affected by head
85. When collecting a fecal sample, it should be
   a. A grab sample preserved with copper sulfate
   b. A composite sample preserved with copper sulfate
   c. A grab sample preserved with sodium thiosulfate
   d. A composite sample preserved with sodium thiosulfate

86. The presence of white pillowing foam on an aeration tank indicates
   a. The aeration tank is loaded hydraulically
   b. The aeration tank is overloaded organically
   c. The aeration tank is underloaded organically
   d. None of the above

87. What test is not ran on a raw wastewater?
   a. BOD
   b. Fecal coliform
   c. Suspended solids
   d. pH

88. What are the top three injuries in wastewater in order?
   a. Face, feet and back
   b. Back, leg and hand
   c. Back, hand and face
   d. Hand, back and leg

89. What is the sludge volume index if the 30-minutes settleability percent solids was 17% MLSS was 1,800 mg/L?
   a. 100
   b. 90
   c. 94
   d. 85

90. A rectangular channel 3 ft wide contains water 2 feet deep and flowing at a velocity of 1.5 ft/sec what is the flow rate in CFS?
   a. 10 cu ft/sec
   b. 11 cu ft/sec
   c. 9 cu ft/sec
   d. 8 cu ft/sec
91. Calculate the BOD for a sample volume of 15 mL.
Initial DO of diluted sample = 8.0 mg/L
DO of sample and dilution after 5 days incubation = 4.0 mg/L

a. 100  
b. 80  
c. 70  
d. 50

92. A plant effluent of 3.5 million gallons per day (MGD) contains 200 mg/L BOD. How many pounds of BOD enter the plant per day?

a. 5,100  
b. 6,000  
c. 5,838  
d. 4,500

93. A plant effluent flowing at a rate of five million pounds per day contains 15 mg/l of solids. How many pounds of solids will be discharged per day?

a. 50 lb/day  
b. 75 lb/day  
c. 70 lb/day  
d. 90 lb/day

94. Percent removal of BOD in a clarifier is 35%, if 70 mg/L are removed, what is the influent BOD?

a. 1000 mg/L  
b. 300 mg/L  
c. 250 mg/L  
d. 200 mg/L

95. What is the sludge age if the tank volume is 0.5 MG, the MLSS is 1,800 mg/L, the primary effluent suspended solids is 110 mg/L and the flow to the plant is 2.0 MGD?

a. 2.4 days  
b. 4.0 days  
c. 3.0 days  
d. 5.0 days

96. A circular clarifier with a diameter of 50 feet and a depth of 10 feet treats a flow of 2 MGD, the detention time in hours is

a. 2 hours
b. 1.8 hours
c. 3 hours
d. 1 hour

97. What is the F/M ratio on an aeration tank if 1,500 pounds of BOD are added per day and 5000 pounds of solids are under aeration?
   a. 0.3
   b. 0.1
   c. 0.2
   d. 0.01

98. A wet well is 10 ft long and 10 ft wide. It takes 10.5 minutes to lower the well 5 ft. The pumping rate GPM is:
   a. 35.7
   b. 357
   c. 400
   d. 110

99. Determine the chlorine demand of an effluent if the chlorine dose is 10 mg/l and the chlorine residual is 1.1 mg/L
   a. 5.3
   b. 8.9
   c. 3.4
   d. 1.0

100. Estimate the velocity of wastewater flowing through a grit channel if a stick travels 32 feet in 36 seconds.
    a. 1.5 ft/sec
    b. 1.2 ft/sec
    c. 0.9 ft/sec
    d. 0.7 ft/sec
### Answers

**Class I & A**

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Class I Review

INTRODUCTION

The IEPA Wastewater Certification Exam consists of 100 multiple choice questions (a, b, c or d). The passing score is 70 questions correct out of 100 questions. The first ten questions are math problems. Each question has only **ONE best correct answer**.

The Class I exam booklet contains:

100 questions

Math formulas and conversion factors

Meanings of acronyms such as **RAS= Return Activated Sludge**

With each exam booklet the examinee will be given an answer sheet, two sheets of scratch paper, and two pencils. All of these materials must be returned at the termination of the exam.

A non-programmable calculator may be used during the exam.

The examinee will have **3 hours** to complete the exam.

The examinee will not leave the room once the exam starts.
CLASS I CERTIFICATION REVIEW QUESTIONS

MATHEMATICS

1. If .06 lbs. of ammonia is oxidized/ lb of MLVSS, how much ammonia is oxidized per day in a 1.82 MG aeration tank carrying a MLVSS of 1800 mg/L?
   a. 1639 lb/day
   b. 432 lbs/day
   c. 2103 lb/day
   d. 4320 lb/day

   Procedure: .06 lbs of NH₃/MLVSS lbs
   MLVSS lbs = Tank Volume X MLVSS mg X 8.34 lbs/gal
   = 1.82 MG/d X 1800 mg/L X 8.34 lbs/gal
   = 27321.8 or 27322 lbs/day of MLVSS

   NH₃ lbs oxidized = 27322 MLVSS lbs./day X .06 lbs NH₃ / MLVSS lbs
   = 1639 lb/day

2. A town has a population of 2300 people. The City could improve it’s tax base if it allows a new industry to start a factory operation in town. The industry would provide @ 100 new jobs. After the plant starts full operation it will discharge a BOD of 400 mg/L into the collection system. Will this be@ __________ than the theoretical BOD of the town before the industry start up.
   a. lower
   b. higher
   c. same
   d. double

   Procedure: Normal population is 2300 people. There is .17 lb BOD per person referring to population equivalent. Therefore:

   .17 lb BOD/person X 2300 persons = 391 lbs of BOD/day

   Comment: Although the BOD of the town almost equals that of the industry, the loading to the plant would be double!

3. A stick travels 30 feet in 20 seconds in a grit chamber. The flow velocity is:

   Ans. In ft./sec
   Velocity = \frac{Distance}{Time} = \frac{30 \text{ ft.}}{20 \text{ secs.}} = 1.5 \text{ ft./sec}
4. A sedimentation tank is 100 ft. long, 30 ft. wide, and 12 ft. deep. What is the flow through the tank if the detention time 2.16 hrs/day?

Ans. In mgd
Area = L X W X H and Volume in gals = cu. ft. X 7.5 gal/ cu. ft.
Detention Time (hrs/day) = \( \frac{\text{Volume} \times 24 \text{ hrs/day}}{\text{Flow (MGD)}} \)

\[
\text{Flow MGD} = \frac{\text{Volume} \times 24}{\text{Detention Time}}
\]

\[
V = 100 \text{ ft.} \times 30 \text{ ft.} \times 12 \text{ ft.} \times 7.5 \text{ gal/cu. ft.} \times 24 \text{ hrs/day} = 6.48 \text{MG}
\]

\[
V = 3 \text{ MGD}
\]

\[
\text{a.} \ 2 \text{ MGD} \\
\text{b.} \ 3 \text{ MGD} \\
\text{c.} \ 3.2 \text{ MGD} \\
\text{d.} \ 4 \text{ MGD}
\]

5. Estimate the detention time in a 30,000 gallon clarifier with a flow of .3 MGD.

Ans. In hrs

\[
\text{Detention Time (hrs/day)} = \frac{\text{Volume}}{\text{Flow}}
\]

\[
\text{D.T.} = \frac{30,000 \text{ gals} \times 24 \text{ hrs/day}}{.3 \text{ MGD}} = \frac{720000 \text{ gal hrs}}{300000 \text{ gal/d}} = 2.4 \text{ hrs}
\]

\[
\text{a.} \ 1.5 \text{ hr} \\
\text{b.} \ 2.0 \text{ hr} \\
\text{c.} \ 2.4 \text{ hr} \\
\text{d.} \ 4.2 \text{ hr}
\]

6. What is the chlorination feed rate if the dosage is 12 mg/L for a flow of 2.0 MGD.

Ans. In lbs/day

\[
\text{Feed/day} = \text{Dosage (mg/L)} \times \text{Flow MGD} \times 8.34 \text{ lb/gal}
\]

\[
12 \text{ mg/L} \times 2 \text{ MGD} \times 8.34 = 200.16 \text{ or } 200 \text{ lbs/day}
\]
7. A sludge applicator applies sludge at 400 gal/ min. It applies a 12 foot wide path, and runs at 3 miles per hour. How many gallons of sludge are applied per acre per hour?

Ans. In gal/ac
Conversion for ft to miles is 5,280 ft/mi
You’re asked for gals/ ac and you’re given 3 miles, 1 hour, 400 gals, and 12 ft.
You have to assume you are going to spread a 12 ft path in 1 hr
Now, how many gallons in an hour? 400gals/min X 60 min/hr = 24,000 gals/hr
You spread 3 miles or 3 X 5,280 ft./mile = 15840 ft
You spread a 12 ft path, therefore how many acres did you apply?
15,840 ft X 12 ft = 190,080 sq. ft = 4.36 ac

Gal/ ac = \frac{24,000 \text{ gallons}}{4.36 \text{ ac}} = 5504.5 \text{ or } 5505 \text{ gals/ac}

a. 200,000 gal/ac
b. 2 500 g/ac
c. 3045g/ac
d. 5505 gal/ac

8. What is the organic loading applied to a trickling filter in pounds of BOD per day for a filter with a diameter of 80 feet, a depth of 4 feet, an influent BOD of 100mg/L and a flow of .5 mgd?

Ans. In lbs./100 cu. ft. Loading(of any kind) = concent. X Flow X 8.34
Loading = 100 mg/L X .5 MGD X 8.34 = 417 lb/day
Now find how many 100 cu. ft in the filter.
Volume = .785D^2 H = .785 (80 ft. X 80 ft. X 4 ft.) = 20096 cu ft
How many 100 cu ft? \frac{20096 \text{ cu. ft.}}{100} = 200.9 or 201 (100 cu. ft.)
Then 417 lb / 201 (100 cu. ft.) = 2.07 or 2.0 lb/100 cu. ft
9. An RBC treats a flow of 1.6 MGD. Surface area is 400,000 sq. ft. The hydraulic loading is ____________.

Ans. Is in gpd/sq.ft. and Hydraulic loading = \( \frac{\text{Flow or Volume}}{\text{Area}} \)

\[ = \frac{1,600,000 \text{ gpd}}{400,000 \text{ sq.ft}} = 4 \text{ gpd/sq.ft} \]

a. 1 gpd/ sq. ft  
b. 2 gpd/sq. ft  
c. 3 gpd/sq. ft  
d. 4 gpd/sq ft.

10. Average BOD to an aeration tank is 125 mg/L. The flow is 2.0 mgd. What is the F/M ratio in the activated sludge plant if the aeration tank is 500,000 gallons and the MLSS is 2400 mg/L?

Ans. In units  \( \frac{\text{Food}}{\text{Micro}} = \frac{125 \text{ mg/L} \times 2 \text{ MGD} \times 8.34 \text{ lbs/gal}}{.5 \text{MG} \times 2400 \text{ mg/L} \times 83.4 \text{ lbs/gal}} \)

\[ = \frac{2085 \text{ lbs}}{10008 \text{ lbs}} = \frac{.208}{.21} \]

a. .05  
b. .5  
c. .3  
d. .21

11. Given the following data calculate how many pounds do you need to waste to maintain a MCRT of 10 days:
   Influent flow- 3.5 MGD  
   Aeration Volume – 1.5 MG  
   MLSS- 3400 mg/L  
   Clarifier Solids – 5000 lbs  
   RAS – 6800 mg/L  
   Eff TSS – 4mg/L  
   Target MCRT -10 days

Ans. In lbs/day

Wasting formula = (lbs sol. In aeration+lbs. sol. In clarifier) – (Lbs sol. In eff) / MCRT
Aer. Solids = 3400 mg/L X 1.5 MG X 8.34 lb/gal = 42534 lbs
Clar. Solids = 5000 lbs
Eff. Solids = 4 mg/L X 3.5 MGD X 8.34 lb/gal = 116.7 or 117 lbs

Waste in lbs = \( \frac{42534 \text{ lbs.} + 5000 \text{ lbs.} - 117 \text{ lbs.}}{10 \text{ days}} = 47417 \text{ lbs.} = 4741.7 \text{ lbs} \)

Or 4742 lbs/day

a. 6237 lbs/day  
**b. 4742 lbs/day**  
c. 3075 lbs/day  
d. 5113 lbs/day

12. The 30 minute settlometer reading is 300 ml. The MLSS is 3400 mg/L. What is the SVI?

Ans. in units  
SVI = \( \frac{30 \text{ min settling ml}}{\text{MLSS (mg/L)}} \times 1000 \)

\( \frac{300 \text{ ml}}{3400 \text{ mg/L}} \times 1000 = 88.2 \text{ or 88} \)

a. 150  
b. 50  
c. 55  
**d. 88**
13. Collection system design flows are not based on:
   a. per capita discharge
   b. industrial discharge
   c. **material available**
   d. storm events

14. Inverted siphons are installed ________ the normal sewer line gradient.
   a. Higher than
   b. **Lower than**
   c. Equal to
   d. Through the

15. If a centrifugal pump has not been primed it can be started if there is a:
   a. positive suction head
   b. low suction lift
   c. neither a or b
   d. **both a and b**

16. You are checking out the lift station when you hear water running back through the check valve on the discharge side of the centrifugal pump after it has shut down. The pump could lose prime, but this pump has never had problems picking up prime again. You should:
   a. Grease the check valve so it will slam shut quicker
   b. Forget it because you know the pump is self priming
   c. **Repair the check valve, as pump may start while rotating in the opposite direction, causing damage to the motor, shaft, and pump**
   d. Take the check valve out completely, as reverse flushing will keep the pump from clogging.

17. Centrifugal pumps use the principle of _____________ to pump solids.
   a. **Vortex formation**
   b. Convection reaction
   c. Reverse eddies
   d. Piston pressure

18. A mixed flow propeller pump employs:
   a. axial flow
   b. radial flow
   c. diagonal flow
d. axial and radial flow

19. A stator in a progressive cavity pump is:
   a. a part that contains that stationary parts that surround the moving parts
   b. the electrical connection inside the rotor that turns the pump on/off
   c. a flexible piece that clears obstructions in the pump
   d. the same as an impeller

20. A piston pump can be damaged if:
   a. the suction valve is open and discharge valve is open
   b. the discharge valve is closed
   c. the suction valve is leaking
   d. the discharge guage bleed valve is missing.

21. Wear rings are installed in pumps to:
   a. keep the shaft stabilized
   b. wear instead of the impeller
   c. keep the impeller in place
   d. plug internal water leakage

22. Faculative ponds:
   a. do not need oxygen
   b. are aerobic on top and anaerobic on the bottom
   c. completely anaerobic
   d. are not found in Illinois

23. Blue green algae in stabilization ponds is caused by:
   a. too much air
   b. red algae die off
   c. low ph and low D.O.
   d. high ph only

24. In a 2 cell lagoon operation it is best to operate the ponds in winter in:
   a. Parallel
   b. Series
   c. The nitrification mode
   d. The denitrification mode

25. A parshall flume:
   a. can only be used in plants over 1 MGD
   b. measures flow based on it’s size and shape
   c. uses the venturi principle
   d. must be adjusted daily for accuracy
26. In a cyclone separator, the heavier solids are:
   a. forced inward and expel at the bottom
   b. forced outside and expel out of the top
   c. **forced outside and go out of the bottom**
   d. forced inward and expel at the top

27. The space between the bars on a bar screen:
   a. 2-4 inches
   b. 2/3 –1 inch
   c. **3/8- 2 inches**
   d. 3-4 inches

28. When televising a sewer line, the camera should move:
   a. Upstream
   b. **Downstream**
   c. It doesn’t matter
   d. Upstream, then downstream

29. A screw pump is a:
   a. centrifugal pump
   b. plunger pump
   c. **positive displacement pump**
   d. piston pump

30. The main difference between a primary clarifier and secondary clarifier is:
   a. there is no difference
   b. flow rate
   c. **primary sludges are denser**
   d. secondary sludges are denser

31. Which of the following conditions does not affect the operation of a clarifier:
   a. Toxic waste
   b. Flow velocity
   c. **Settleability rate tests**
   d. Septicity from the collection system

32. In a single phase condition, if the motor is not rotating, the motor will:
   a. **Start immediately**
   b. Will cause excessive noise
   c. Will not start
   d. Will not cause excessive heat
33. In a three phase system a magnetic starter is usually energized by a:

a. 115 V circuit  
b. 230 V circuit  
c. 24 V circuit  
d. 440 V circuit

34. In a pneumatic ejector the ejector does not discharge. The problem might be:

a. The impeller is clogged  
b. The air pressure is over 2psi per foot of discharge head  
c. The counterweight is in the down position  
d. The strainer line is clogged

35. Surface loading rates for clarifiers are used to indicate:

a. whether to have a rectangular or circular clarifier  
b. effectiveness of solids removal efficiency  
c. weir effectiveness  
d. solids loading

36. An Imhoff tank removes @:

a. 10% of BOD and 20% SS  
b. 25% of BOD and 45% SS  
c. 50% of BOD and 60% SS  
d. 60% of BOD and 80% SS

37. Odors from the gas vents on an Imhoff tank can be controlled by:

a. aerating the Imhoff tank  
b. adding copper sulfate to the sedimentation area  
c. putting hydrated lime in the gas vent area  
d. removing all of the sludge

38. Which of the following is not a typical percentage for primary clarifier efficiency?

a. Bacteria – 25% - 75%  
b. settleable solids – 90% - 95%  
c. Total solids – 60% - 70%  
d. BOD – 25% - 35%

39. Grit should be disposed of:

a. in gardens
b. behind the fence
c. buried in a landfill
d. recirculated for further degradation

40. Ineffective preliminary treatment will:
   a. be taken care of by the secondary processes
   b. reduce costs on grit removal
   c. will cause excessive wear on downstream equipment
   d. will reduce organic loading

41. Anaerobic digestion has three stages: extracellular enzymes action, acid forming, and:
   a. recirculation
   b. supernation
   c. methane formation
   d. sludge disposal

42. The best temperature for anaerobic digestion takes place between 90 to 100°F. Digestion almost ceases at:
   a. 80°F
   b. 70°F
   c. 60°F
   d. 50°F

43. An acidity / alkalinity ratio of ______ will result in inhibition of methane production.
   a. .5
   b. .4
   c. .6
   d. .8

44. A solids profile in an aerobic digester is used to:
   a. to keep the operator trained in taking samples
   b. provide an determination of sludge uniformity
   c. to determine proper supernatant levels
   d. insure against digester “freeze”

45. The supernatant draw in an anaerobic digester appears poor. It has an excessive amount of solids. What could be the problem?
   a. The supernatant drawoff is not as frequent.
   b. Raw feed point is too far from the draw off time.
   c. Excessive mixing and not enough settling time.
   d. Drawing off too much sludge.
46. What is the most important advantage of having a floating cover on an anaerobic digester?
   a. It is easier to operate.
   b. **It varies with the level, thus no vacuum can occur.**
   c. It produces more gas.
   d. You never have to mix or supernate.

47. Gas and air will be present in an anaerobic digester. If the mixture is not controlled, what could happen?
   a. The bacteria will be killed.
   b. There will be excessive odor.
   c. The digester will cool, causing heat exchanger failure.
   d. **An explosive condition may occur.**

48. The underdrain system in a trickling filter does what?
   a. Supports the filter media.
   b. Provides an air conduit for the filter interior.
   c. Provides collection of the treated wastewater.
   d. **All of the above.**

49. During an excessive uncontrolled sloughing occurrence you decide to correct the problem by…
   a. Increasing recirculation rate
   b. Decreasing recycle rate
   c. **Increase rate but slow down distributor arm rotation**
   d. Decrease rate and increase distributor arm rotation

50. Which of the following is **not** a method for correcting ponding in a trickling filter?
   a. Remove debris i.e. leaves etc from surface
   b. Check organic and hydraulic loading and correct.
   c. **Flood the filter every day with 5 mg/L of Copper Sulfate**
   d. Jet with hose, rake or stir the media

51. If the slime growths on a trickling filter start to dry out, an operator should
   a. Immediately dose the filter with 1 mg/L of chlorine
   b. Apply a fine spray of chlorinated water on the media surface
   c. Divert filter influent to another filter or treatment unit.
   d. **Increase recirculation rate.**

52. The filter media in an RBC rotates at @_________ RPM and is submerged @_________ percent.
a. **1.5 and 40**  
b. 2.0 and 30  
c. 1.0 and 25  
d. 2.5 and 10

53. White growth on the media of an RBC is a  

a. Good indication of quality operation  
b. **Typical sign of organic overload**  
c. Sulfur bacteria indicator only  
d. Common sight and should be ignored

54. When snails develop on the media of an RBC it can be a problem because  

a. the operator is trying to grow the organism to increase unit efficiency  
b. the RBC is trying to remove CBOD  
c. **the RBC is trying to remove nitrogenous BOD**  
d. the recirculation rate is too high

55. If the RBC is off longer than 4 hours, the operator should  

a. keep the RBC rotating by hand until relief arrives  
b. not worry as the zoogleal film will regenerate  
c. increase recirculation and spray the media  
d. **turn the RBC ¼ turn every 4 hrs and spray the media**

56. Gravity thickeners should be fed sludge on a continuous basis because  

a. **it promotes a stable sludge blanket**  
b. intermittent feeding is not practical  
c. it requires less make up water  
d. it is easier to calculate feed rates

57. In a DAF thickener, the feed mixes with pressurized recycle flow _______ entering the main flotation compartment.  

a. before  
b. after  
c. either before or after  
d. none of the above

58. Vibration measurements should be made periodically on centrifuges to:  

a. Check centrifugal force for better centrate quality  
b. Insure proper polymer addition  
c. **Check for increases, thus signaling bearing failure**  
d. Check SVI levels
59. In line mixers or conditioning tanks are used in belt press operation to mix polymer and sludge feed. Which is not a feed point?
   a. 2-3 feet upstream of conditioner
   b. 25 ft upstream of the conditioner
   c. at the conditioner
d. **1 foot after the conditioner**

60. You are operating a belt press at a normal loading rate for aerobically digested and supernated sludge with @ 2.5 % solids loading. The polymer feed is adequate for the sludge feed, and you have been producing @ a 10% cake. Lately the cake has been decreasing in solids quality and is not as good. Solids feed rate and percentage has not changed. What most likely is the problem?

   a. A hose for wash down has been left on in the feed trough
   b. Someone switched polymer product
c. **The sludge had changed in ionic charge**
d. There is no problem. Don’t worry it happens occasionally.

61. If you were to use a 15% dilution factor how many ml of sample would you add to a 300 ml BOD bottle?

   \[ \text{ml} = \text{dil. Factor} \times 300 \text{ ml} \]

   a. 20 ml
   b. 40 ml
c. **45 ml**
d. 15 ml

62. You are gaining D.O. in a BOD test after the 5 day incubation period. What could be the problem?

   a. **The dilution water is bad.**
   b. The D.O. probe is faulty.
   c. This is normal. Leave it in incubation for 5 more days.
d. Misuse of dilution factor.

63. If you use a 250 ml of sample in a TSS test what would be the TSS in mg/L? If the subtracted weight was .0725 g?

   \[ \text{mg/L of TSS} = \frac{\text{Subtr. Wt gr.} \times 1000 \times 1000}{\text{ml of sample}} \]

   \[ = \frac{.0725 \times 1000 \times 1000}{250 \text{ ml}} = 290 \text{ mg/L} \]
64. When using a selective membrane method for free ammonia nitrogen must be added after the ammonia probe has been immersed in the sample.
   a. 2 ml of HCl
   b. 1 ml NH₃
   c. **1 ml NaOH**
   d. 2 ml of H₂SO₄

65. In lab monitoring, it is mandatory for every lab:
   a. Dump dilution water daily
   b. Clean the glassware with any dishwashing soap
   c. Calibrate scales daily
   d. **Record temps of incubators with registered thermometer**

66. Microscopic examination of an MLSS sample shows a predominance of nematodes and rotifers. The observation of settleometer reading should indicate
   a. A bulking condition
   b. Slow settleability
   c. **Rapid settling**
   d. Dispersed floc

67. The difference between an oxidation ditch and an extended air plant is:
   a. The addition of a contact tank
   b. One uses diffused air only
   c. The oxidation ditch is fill and draw
   d. **There is no difference**

68. The average flow in an oxidation ditch varies
   a. .5 – 1.0 ft./sec
   b. 1.0-1.5 ft./sec
   c. **1.5-2.0 ft./sec**
   d. 2.0 ft./sec with no variation

69. Where should D. O. be measured in an oxidation ditch?
   a. **@20 ft from the rotor**
   b. at the rotor
   c. **@ 15 ft from the rotor**
   d. at the discharge weir
70. Dark heavy foam is forming in the aeration tanks of an activated sludge Plant. D.O. is adequate. Mixed liquor has not changed except the foam formed in the settleometer leaves an oil like presence on the glass of the settleometer. The foam grows every day until it starts coming over the catwalks of the plant and clarifier. The dark residue left is greasy and slippery. What is probably the problem?

a. Filamentous organisms  
b. Inadequate air/ foam ratio  
c. **Nocardia development in the MLSS**  
d. Too much wasting

71. What is one way of solving the problem in question 70.

a. **Develop an anoxic zone at the influent of the aeration tank**  
b. Shut down the local industries  
c. There is no problem, the foam usually leaves with changes in temperature  
d. Break up the foam by shearing with excess aeration

72. In a normal settleability test of MLSS in a 2000 ml settleometer what would be the settling percentage after the first 5 minutes?

a. 30%  
b. 45%  
c. 50%  
d. 65%

73. Return sludge volume should be regulated by

a. solids growth rate  
b. condition of sludge  
c. settleability percentage  
d. all of the above

74. If the flow rate to the aerator is 5 MGD and the settleable solids reading after 60 minutes is 18%, what would be the return rate?

Return flow = 60 min settling percentage X Flow, MGD  
.18 X 5 MGD = .9 MGD

a. 5 MGD  
b. 1 MGD  
c. .5 MGD  
d. .9 MGD
75. When working on the motor of a mechanical aerator, **providing you are qualified;** the first step in your maintenance procedure should be
   a. Get all the needed parts and tools
   b. **Lock out and Tag the electrical power to the unit.**
   c. Remove the inspection plate
   d. Mark down all manufacturer’s info on ID plate

76. In a Dissolved Air Flotation unit polymer generally is injected
    a. **at pressurized recycle and sludge feed**
    b. at the sludge feed
    c. only with the non pressurized recycle
    d. when air to solids ration is < .02

77. Clarifiers torque should not exceed
   a. 50%
   b. 25%
   c. 15%
   d. **10%**

78. When stabilizing sludge using the lime stabilization technique, sufficient lime must be added with the liquid sludge to raise the pH of the mixture to:
   a. 8.3 and maintain for 2hrs only
   b. 12 and maintain for 30 mins
   c. 10 and maintain for a minimum 2hrs
   d. **12 and maintain for a minimum of 2 hrs**

79. Wasting sludge in an activated sludge plant is necessary to
   a. keep drying beds filled
   b. control the pH in the aeration tank
   c. monitor microorganisms in the process
   d. **maintain the proper balance for F/M or MCRT control**

80. Oxygen Uptake Rates are measured using
    a. a 10min O₂ depletion average
    b. MLVSS
    c. BOD results only
    d. **a and b**

81. Per NPDES regulations effluent metering should be calibrated
a. Monthly
b. **Annually**
c. Every NPDES renewal  
d. Never unless there’s a problem

82. The difference between Class A reduction and Class B reduction in the 40CFR, Part 503 is

a. There are no restrictions for Class B sludge  
b. Class A sludge can be applied on corn land only  
c. **Class A sludge is virtually pathogen free**  
d. Class B is for plants over 100,000 GPD

83. Which is **not** an application point of chlorine for the control of bulking in an activated sludge plant?

a. In the RAS stream  
b. **In the influent**  
c. In the aeration tank  
d. At each aerator

84. If there is no permanent vehicle treadway in a sludge drying bed the operator should :

a. Use the vac truck to vacuum off dried sludge  
b. If sludge is dry, refill bed to cover dried sludge  
c. **Lay plywood planks and manually remove sludge**  
d. Drive on the bed if the underdrain is greater than ten feet deep

85. According to the IEPA how often should the lab balance be calibrated?

a. **Yearly**  
b. Semi-annually  
c. Every 3 years  
d. 180 days prior to NPDES renewal

86. Manganous sulfate, alkali-iodide-azide, starch, sulfuric acid are chemicals used in what test?

a. West test for nitrates  
b. Bennet test for oxygen  
c. Amanaphthol test for nitrates  
d. **Winkler test for oxygen**
87. A smoke test is performed to evaluate

   a. Efficiency of exhausts in the plant
   b. **Illegal connections in a collection system**
   c. Efficiency of the Fire Dept Response
   d. The effectiveness of low nicotine cigarettes

89. When the hydrogen sulfide level rises above _____ ppm, an audible and visual alarm on a multiple gas meter should activate.
   a. 19.5
   b. **10**
   c. 1
   d. 15

90. RBC units are covered to

   a. prevent algal growth
   b. increase condensation
   c. prevent rain
   d. **prevent freezing**

91. Oxygen in a aerobic pond is produced by

   a. surface aerators
   b. photosynthesis
   c. **algae liberating oxygen**
   d. sludge gas

92. What is the dry weight of 200 mg/L of Zinc in sludge if the percent solids 24 percent?

   \[
   \text{Dry weight in mg/kg} = \frac{\text{mg/L of metal}}{\text{% solids}} \\
   = \frac{200 \text{mg/L}}{0.24} = 833.3 \text{ mg/kg}
   \]

   a. 8.34 mg/kg
   b. 100 mg/kg
   c. 244 mg/kg
   d. **833 mg/kg**

93. What is the purpose of a confined space entry permit?

   a. Document hazardous conditions which may lead to lawsuits.
   b. **Ensure the use of safety precautions and safe procedures**
   c. Inform the regulatory agency of dangerous work being undertaken
   d. Protect workers from hazardous materials in the work space
94. Proper sampling techniques are specified in
   a. maintenance manuals
   b. MOP 1
   c. Plant specs
   d. **Standard Methods for the Examination of Water and Wastewater**

95. A set of fecal coliform test results include a value of TNTC. In calculating the geometric mean, what value you give to this result?
   a. 0
   b. same value as highest test result
   c. same value as median value
   d. **drop the value from the calculations.**

96. Floating digester covers are kept level by
   a. **gas recirculation**
   b. mixing
   c. supernatant drawoff
   d. the Kraus process

97. When lime is used in a clarifier, it enhances
   a. a better return rate
   b. growth of sparaletous natans
   c. **settleability**
   d. sweeter tasting effluent

98. When someone is speaking of damage to the olfactory system to what are they be referring?
   a. an old factory nearby
   b. the blower room equipment
   c. **gas monitory sense of smell**

99. Why is thermal conditioning used in some plants?
   a. **It improves thickening characteristics of sludge**
   b. It prevents odors
   c. It replaces the need for anionic polymer
   d. It improves the water holding capacity of the anaerobic cell

100. What are splash pads use for in sand filters?
   a. To walk on when raking the filter
   b. To improve drainage
   c. To equalize flow on the filter
   d. **To prevent deterioration of the surface due to splash force**
Activated Sludge
Define first stage and second stage BOD relative to nitrification (carbonaceous versus nitrogenous BOD removals).

Describe where the activated sludge process fits in the wastewater treatment flow pathway.

Define the activated sludge process.

Describe the secondary treatment process of activated sludge systems.

Define the role microorganisms have in the activated sludge process.

Identify and explain the meaning of the following terms:
- MLSS
- SVI
- WAS
- RAS

List the important conditions necessary for optimum bacterial growth in an aeration basin of activated sludge systems.

Draw a diagram of the secondary activated sludge process and name the components.

Describe the relationship among D.O., BOD loadings, floc settleability, filamentous bacteria and pinpoint floc.

Why is sludge wasting important in an activated sludge system?

List the main controls an operator has over the activated sludge processes.

Describe the layout of the common type of extended aeration tanks.

What is the definition of sludge age and what is the expected sludge age in an extended aeration process?

What is the function of an air lift pump in an extended aeration system?

Describe the differences among and advantages/disadvantages of conventional activated sludge, extended aeration, contact stabilization and complete mix systems. For example, which of the four processes has the longest detention time? What are the advantages of the longer detention time?

What is the function of cathodic protection for a metal-built package plant?

Which two methods of aeration are commonly used in the activated sludge process? Describe the
mechanism of aeration.

What are the advantages and disadvantages of fine bubble air systems?

What can happen if not enough air is supplied to an activated sludge system?

In the activated sludge systems, foam can appear on the surface of the aeration tank. How could the color of foam indicate the condition of the aerator?

Explain sludge wasting:
- How to dispose of excess sludge
- What is the consequence of NOT wasting sludge?
- Etc.

Describe the normal operation of an activated sludge plant.

Describe the abnormal operation of an activated sludge system.

Describe trouble-shooting of activated sludge systems.

Describe the settling test for activated sludge and explain how the results of the test should be used to control the plant operation.

Describe the flow path and major components of oxidation ditches.

Explain why the oxidation ditch process is less affected by cold weather than the conventional activated sludge processes?

What is the result of wasting sludge from an oxidation ditch system.

At what velocity does the liquid in an oxidation ditch need to be maintained and why?

How is the dissolved oxygen level in oxidation ditches controlled?
To build up MLSS in an oxidation ditch in order for foam reduction, what control should be manipulated?

What is the most essential component of an oxidation ditch and why?

Discuss essential design features of package plants.

Explain the term "endogenous respiration".

What types of laboratory data are needed to be recorded for proper operation of an activated sludge process?
Define the term "organic loading". Compare the organic loadings of different activated sludge processes.
Describe three types of air diffusers in activated sludge systems. What are their advantages and disadvantages?

What level of D.O. should be maintained in an aeration tank of an activated sludge system? Where should this level be maintained?

Describe what will happen when the return sludge rate is too low in an activated sludge system.

Describe what will happen if the mixed liquor suspended solids are allowed to increase beyond the optimum range in an activated sludge system.

Describe the term "sludge bulking".

Explain why sludge may turn septic in an activated sludge system.

Describe rising sludge in an activated sludge system. What causes rising sludge?

Explain why activated sludge is called a "mixed culture".

Describe the microorganisms found in an activated sludge system.

Which is the 'main worker' among the various organisms found in activated sludge?

**Clarifiers/Sedimentation**

Describe the purpose of sedimentation.

Differentiate between primary and secondary (or final) clarifiers.

Describe the essential components of a rectangular clarifier.

Describe the essential components of a circular clarifier.

What is the purpose of the effluent weir in a circular clarifier?

Black and odorous septic wastewater is leaving the primary clarifier of your wastewater plant. What could be the causes and their solutions?

You found that sludge was hard to pump from the hopper of the secondary clarifiers. What could be the causes and their solutions?

Excessive corrosion is observed on the clarifier of your package extended aeration unit. What could be the causes and their solutions?

At what location would you collect samples in order to determine the efficiency of a clarifier?
What water quality parameter should be measured to determine the efficiency of a clarifier?

Describe the factors affecting clarifier efficiencies.

Describe the method to determine the proper intervals of sludge pumping from a clarifier.

Describe the proper maintenance program for a clarifier.

Define specific gravity.

Describe the temperature effect on sedimentation of a particle in a clarifier.

Describe short-circuiting in a clarifier.

Discuss secondary clarifiers.

What are the common causes of short-circuiting in a clarifier and their remedial measures?

Describe the relationship between the detention time and particle settling rates in a clarifier.

Describe why it is important to know weir overflow rates in a clarifier.

Define surface settling rates in a clarifier.

Explain the "hydrostatic" sludge removal system.

Describe the layout of an activated sludge plant and the location of secondary clarifiers.

Describe three variations of sludge removal mechanisms.

What will happen if sludge is allowed to stay in a secondary clarifier too long? What is the solution?

**Disinfection**

What are pathogenic organisms?

Describe the difference between the terms "disinfection" and "sterilization".

Describe the reaction of chlorine in wastewater. What is "chlorine demand"?

Describe the reaction of chlorine with ammonia. What are the names of the reaction products?

Describe factors affecting disinfection of wastewater by chlorine.

Describe "post-chlorination".
Discuss the importance of mixing chlorine in a chlorine contact tank.

Discuss four methods of chlorine residual measurement.

Discuss the hazards in handling chlorine gas.

Describe the type of breathing apparatus necessary when entering a room with a chlorine leak.

Discuss the handling of chlorine cylinders.

Describe a "hypochlorinator".

Discuss the need for dechlorination.

What methods are available for dechlorination?

Discuss the properties of sulfur dioxide.

Discuss the typical application point of sulfur dioxide for dechlorination.

Understand how UV disinfection works.

Understand what kind of light is used in UV disinfection.

**Fixed Film**

Describe a trickling filter.

Where is "zoogleal film" found on a trickling filter media?

What are the essential components of a trickling filter?

Describe the function of the following parts of a trickling filter:

< distributor arm
< filter media
< under-drain

Discuss slime growth on the filter media of a trickling filter.

Describe the recirculation process in a trickling filter.

What test can best measure the efficiency of a trickling filter?

Why can a trickling filter withstand shockloads well? Describe a shockload.
What are some of the problems observed in the operation of a trickling filter?

Describe "ponding" in a trickling filter and its remedial measures.

Discuss odor problems emanating from a trickling filter and its preventive measures.

Describe "sloughing" occurring in a trickling filter.

How is the speed of the distributor arms in a trickling filter controlled? How can you reduce the speed of rotation?

What is the hydraulic loading on a trickling filter and how is it expressed?

Describe the RBC (rotating biological contactor) process.

Describe the essential components of an RBC.

What are the purposes of a cover for an RBC unit?

Describe normal and abnormal appearances of slime on the RBC media.

List some safety hazards operators may encounter when working around RBC units.

**Laboratory, Sampling & Monitoring**

Describe the following terms used in laboratory analyses.

- buffer & buffer capacity
- meniscus
- N (Normal)

Explain the relationship between Celsius and Fahrenheit temperature scales. What are the boiling temperatures of water in degrees Celsius and degrees Fahrenheit?

Discuss the metric system.

List the chemical formulas of the following compounds:

- sodium chloride
- sodium hydroxide
- sulfuric acid
- ferric chloride

Describe the functions of the following lab equipment:

- beakers
- graduated cylinders
State the function of a desiccator.

Explain the different uses of flasks and volumetric flasks.

Explain the proper method of use of three types of pipets.

Describe laboratory work (bench) sheets.

Discuss laboratory safety at a wastewater treatment plant laboratory.

Discuss the safe storage of laboratory chemicals as it relates to proper location and the compatibility of various types of chemicals.

Explain the following units of concentration used in recording laboratory data:
- mg/l
- mg/kg
- % solids

Describe proper fire prevention measures necessary at a wastewater treatment plant laboratory.

Discuss the accuracy expected from the use of analytical balances and graduated cylinders.

Describe proper laboratory techniques in handling acids and mercury.

Explain why it is important to collect samples correctly.

Discuss the importance of composite samples and their use in the laboratory tests.

Explain grab samples and composite samples.

Describe the proper sample preservation methods and the maximum recommended holding time for the following tests:
- ammonia
- BOD
- pH
- chlorine
- Total Suspended Solids (TSS)

Specify temperature requirements in degrees C (Celsius) for each of the following:
- BOD incubator
- TSS drying oven
discuss the production and hazard of hydrogen sulfide in the sewer and at wastewater treatment plants.

Discuss how a Secchi disc can be used at a wastewater treatment plant.

Describe precautions one needs to take in running tests for suspended solids.

Describe settleability tests, and how the results can be used in plant process control.

Explain the difference between the settleable solids test and the settleability test, the method and the use of information.

Discuss the measurement of the sludge volume index and its application in the activated sludge processes.

Discuss the determination of "sludge age".

Why are we concerned about the concentration of coliform group bacteria?

Why is it important to maintain residual chlorine in a chlorine contact tank?

Describe the precautions necessary in the use of a D.O. probe for BOD tests.

Explain the meaning of BOD.

Describe the procedure for BOD measurement.

What are the requirements of the minimum depletion and the minimum residual D.O. in BOD tests?

Explain the relationship between temperature and percent saturation with regard to dissolved oxygen.

Describe precautions required in the BOD tests.

"Blank tests" in BOD measurement are a requirement. What is the purpose?

What does the term "pH" represent? What is the range of pH? What is the neutral pH?

What are the precautions one should take in the pH measurement?

Discuss what is measured in laboratory water when it is tested for specific conductance.

Discuss the importance of temperature measurement. How is a thermometer calibrated?
Preliminary Treatment
Identify three different types of preliminary treatment and describe the purpose of each.

Define “grit” and “detritus”.

Describe methods for the ultimate disposal of screenings.

Describe the purpose and essential parts of comminutors.

Describe the composition of grit.

Describe the purpose of grit channels and proportional weirs.

Describe aerated grit chambers. What are the side benefits of aerated grit chambers?

Describe the final disposal methods of grit.

What are the benefits of pre-aeration?

If screens or comminutors are overloaded or bypassed, what problems can one expect?

Safety and Maintenance
What precautions should be taken against the risk of infection by operators at a wastewater treatment plant?

Discuss the dangerous gasses encountered in sewers and wastewater treatment plants.

Discuss Material Safety Data Sheets (MSDS).

Describe the proper way to remove a manhole cover.

What is the greatest hazard when working on a clarifier?

Describe how one can locate chlorine leaks in a chlorination system.

Describe the function of leaking water in a packing gland for a pump.

Describe the water level control system found in a wet-well of a pumping system.

Compare mechanical seals and packings in a pumping system.

Describe the air-gap system for water supply at a wastewater treatment plant.
Explain the concern for cross-connection in a pumping system.

Describe the possible causes when a pump will not start.

What should one check if the flow rate of a centrifugal pump is reduced?

How would you determine the schedule of lubrication for a pump?

What could cause a pump shaft and motor to spin backward?

Compare positive displacement pumps with centrifugal pumps. Where are positive displacement pumps used and what is the most important thing to remember in their operation?

Compare two types of blowers.

Why are fine bubble diffusers easily clogged?

Describe two types of headers in the aeration system.

Why is an oil cooler unit sometimes used for centrifugal blowers?

What precautions should be taken when working with blowers?

Can you clean air filters while a blower is in operation?

Define "velocity" and Q=AV.

Describe flume-type head-area meters. What is their application in a wastewater treatment plant?

Describe weir-type head-area meters. What is their application in a wastewater treatment plant?

What are the purposes of flow measurement at a wastewater treatment plant?

**Solids Treatment & Handling**

Explain the sludge digestion process.

Describe the anaerobic sludge digestion process and its purpose.

Describe the aerobic sludge digestion process.

Compare the aerobic and anaerobic digestion processes.

Describe the relationship between aerobic digestion and endogenous respiration.
Describe the operational procedures of aerobic digesters.

Describe how floating sludge can affect the operation of aerobic digesters.

Describe construction of sludge drying beds.

Describe the operation of a sludge drying bed.

Describe the types of mechanical dewatering methods available.

Describe five methods of final disposal of sludge.

**Mathematics**

Given the volume of a sedimentation tank and the flow rate, calculate the detention time of the sedimentation tank.

Given a flow rate in gpm, convert it into MGD.

Given the distance and time of travel of a stick in a grit channel, calculate the velocity of travel.

Given the influent and effluent TSS, calculate the TSS removal efficiency in percent.

Given the concentration of MLSS and the volume of an oxidation ditch, calculate the pounds of solids under aeration.

Given the influent BOD and the required percent removal, calculate the required maximum effluent BOD.

Given the dimensions of an aeration tank (circular), calculate the volume of the tank.

Given the 30 minute settleable solids (%) and MLSS, calculate the sludge volume index.

Given the flow totalizer readings at the beginning and end of a month (30 days), calculate an average flow rate for the month.

Given the effluent BOD in mg/l and an effluent flow rate, calculate the BOD loading to a receiving stream in pounds per day.

Given the influent and effluent TSS of a wastewater plant, calculate the overall TSS removal efficiency.

Given the TSS of a primary effluent, the daily flow and the total solids (pounds) in an aeration tank, calculate the sludge age.

Given the estimated BOD of a sample, calculate the ml of sample to be added to a BOD bottle (300 ml).
Given the sample volume of a BOD test, the initial D.O. and the final D.O., calculate the sample BOD.

Given six BOD values in mg/l, calculate the mean BOD in mg/L.

Given the flow rate and the desired dosage of chlorine, calculate the chlorine feed rate in pounds per hour.

Given test results on the TSS determination using a Gooch crucible (sample volume, crucible weight w/ and w/o residue), calculate the TSS in mg/l.

Given the required chlorine feed rate and the strength of HTH (high test hypochlorite), calculate the pounds/day of HTH required.

Given the volume of water in liters, calculate its weight in grams.
Surface loading rates for clarifiers are used to indicate effectiveness of solids removal efficiency.

Microscopic examination of a MLSS sample shows a predominance of nematodes and rotifers. **The settleometer readings should indicate rapid settling.**

There is no difference between an oxidation ditch and an extended air plant.

The average flow in an oxidation ditch varies 1.5 to 2.0 ft./sec.

The D.O. should be measured at 15 feet from the rotor in an oxidation ditch.

Dark heavy foam is forming in the aeration tanks of an activated sludge plant. D.O. is adequate. Mixed liquor has not changed except the foam formed on the settleometer leaves an oil-like presence on the glass. The foam grows every day until it starts coming over the catwalks of the plant and clarifier. The dark residue left is greasy and slippery. This scenario indicates Nocardia development in the MLSS.

One method of dealing with Nocardia is to develop an anoxic zone at the influent of the aeration tank.

A normal settleability test of MLSS in a 2000 ml settleometer would show a 65% settling after the first 5 minutes.

Return sludge volume should be regulated by solids growth rate, condition of sludge, and the settleability percentage.

The flow rate to the aerator is 5 MGD, and the settleable solids reading after 60 minutes is 18%, then the return rate should be **9 MGD.**

\[
\text{(Return flow} = 60 \text{ minute settling percentage } \times \text{ Flow, MGD)}
\]

\[
.18 \times 5 \text{ MGD} = 0.9 \text{ MGD return flow}
\]

Clarifiers torque should not exceed 10%.

Wasting sludge in an activated sludge plant is necessary to maintain the proper balance for F/M or MCRT control.

*Oxygen Uptake Rates are measured using a 10 minute oxygen depletion average and MLVSS.*

*Per NPDES regulations, effluent metering must be calibrate annually.*
The influent is NOT a point of application of chlorine for the control of bulking sludge in an activated sludge plant.

When lime is used in a clarifier, it enhances settleability.

Settleability rate tests do not affect the operation of a clarifier.

Samples for a S.O.U.R. test should be taken at the aeration tank outlet.

D.O. has suddenly dropped but is stable. Valve to air diffuser is half open. Influent flow is normal for dry weather. Influent wastewater is normal. Valve is opened all the way with no change in turbulence of the tank or the D.O. *(Air line or diffuser is plugged.)*

A plant with a high organic load should use extended aeration treatment.

The secondary clarifier has a high sludge blanket. Collector arms are operating. Return sludge is going in automatic, and the flow coming out seems to be normal. The level indicators seem to be operating properly. *(Accelerate sweep arm, for more sludge removal.)*

Poor settling sludge in the clarifier following a series of RBCs, is most likely NOT to be caused by increased D.O.

In an activated sludge process with nitrification in the activated sludge tank, the most important factor is D.O.

If you are collecting grab samples and the permit requires composite samples, this is a punishable, non-compliance issue.

In activated sludge, D.O. is affected by bio-activity and applied air.

Slow settling or non-settling sludge in a sedimentation tank could be an indicator of filamentous bacteria.

An activated sludge process with the nitrification process being completed in a separate system from activated sludge tank, that system is usually operated with a greater D.O. than the activated sludge.
A main difference between a primary and a secondary clarifier is the detention time.

The activated sludge process works due to biology in the aeration tank consuming solids from the influent, then settling out in the secondary clarifier from the increased weight.

Dark, greasy film on the surface of an aeration tank indicates old, over-oxidized sludge.

Secondary clarifier pin-floc is floating to the surface and over the weirs. The sludge settles well, and the blanket is dense, with a clear supernatant. **(Over-aeration may be causing the pin-floc.)**

Measurement of MLSS indicates the amount of solids inventory under aeration.

An activated sludge system with a pH of 6.8, good D.O., and a concentration of ammonia nitrogen in the effluent indicates **low-alkalinity** problems.

Industrial waste treatment plants usually have to seed BODs.

Sodium carbonate can be used to increase pH in a nitrification tank.

D.O. solubility in water increases when the temperature decreases.

VSS is the best method for measuring total organic suspended solids in an activated sludge system.

Decrease the waste time if experiencing white billowing foam on an activated sludge tank.

Turbid effluent from a secondary clarifier will cause BOD violations, SS violations, and blind/plug tertiary filters.

**After a settleable solids test, the solids settle to the bottom then float to the top after 30 minutes. (Reduce the aeration rate.)**

In the activated sludge process, cold-weather treatment efficiency decreases due to reduced biological activity.

NPDES permit requires keeping treatment facility records for 5 years.
Bacteria are NOT significantly affected in a clarifier.

Suspended solids and D.O. are the tests used in the S.O.U.R. test.

Rotor height controls the amount of oxygen in an oxidation ditch.

The Kraus process is used when the ratio of carbonaceous to nitrogenous is high.

Contact stabilization processes use re-aeration.

A baffle before the weir in a sedimentation tank keeps the solids from going over the weir.

Normal activated sludge F/M ratios are in the .2 to .4 range.

Bulking in a secondary clarifier is usually caused by filamentous bacteria.

18 hours is the average detention time for an extended aeration plant.

The oldest, most common type of activated sludge process is called "conventional".

Filamentous bacteria can be treated by chlorinating return sludge flows.

An SVI range of 50 to 150 indicates a good settling sludge rate for the amount of sludge in the system.

A sludge age of 19 days means that the sludge has been in the system for 19 days.

H2SO4 can be added to preserve samples for testing.

The 30 minute settling rate is the reading used for calculating the Sludge Volume Index, (SVI).

Extended aeration has the lowest Sludge production

Oxidation Ditch designed for 24 hr retention time.

Plug flow is when untreated and treated RAS is introduced into the head of Plant.
It takes 4.6 m/l oxygen to remove 1 gram of ammonia nitrogen.
If .06 pounds of ammonia are oxidized per pound of MLVSS, how much ammonia is oxidized per day in a 1.82 MG aeration tank with MLVSS at 1800 mg/L?

\[ 1.82 \text{ MG} \times 1800 \text{ mg/L} \times 8.34 = 27322 \text{ lbs. MLVSS} \]

\[ 27322 \text{ lbs.} \times .06 \text{ lbs.} = 1639 \text{ lbs./day of ammonia oxidized.} \]

A town has a population of 2300 people. This town could expand the tax base if it allows a new industry to start operations. The industry would provide 100 new jobs. Once the plant is at full production, it is estimated the average 0.120 MGD discharge will have a BOD of 400 mg/L into the town's collection system. What happens to the wastewater treatment plant?

Town: Population Equivalent = \( .17 \text{ lbs. BOD/day/person} \times 2300 \times .17 = 391 \text{ lbs. BOD/day} \)

Industry: \( 400 \text{ mg/L} \times 0.120 \text{ MGD} \times 8.34 = 400 \text{ lbs. BOD/day} \)

The organic loading to the treatment plant almost doubles, to 791 pounds per day. The hydraulic loading increases 52%.

Population Equivalent = \( .17 \text{ lbs. BOD/day/person} \times 2300 \times .17 = 391 \text{ lbs. BOD/day} \)

Industry: \( 0.12 \text{ MGD} \times 400 \text{ lbs. BOD/day} = 400 \text{ lbs. BOD/day} \)

A stick travels 30 feet in 20 seconds in a grit chamber. What is the flow velocity?

\[ \text{Velocity} = \frac{\text{distance}}{\text{time}} = \frac{30 \text{ ft.}}{20 \text{ sec.}} = 1.5 \text{ ft./sec.} \]

A sedimentation tank is 100 feet long, 30 feet wide, and 12 feet deep. What is the flow through the tank if the detention time is 2.16 hrs./day?

Display: \[
\begin{align*}
\text{Detention time (hrs./dy.)} & = \frac{\text{Volume} \times 24 \text{ hrs./dy.}}{\text{Flow (MGD)}} \\
100 \times 30 \times 12 & = 360000 \text{ cu. Ft.} \times 7.5 \text{ gals./cu. ft.} = 270000 \text{ gals.} \times 24 \text{ hrs./dy.} = 6.48 \text{ MG} \\
\frac{6.48 \text{ MG}}{2.16 \text{ hrs./dy.}} & = 3.0 \text{ MGD}
\end{align*}
\]
Estimate the detention time in a 30000 gallon clarifier with a flow of 0.3 MGD.

\[
\text{Detention time (hrs./dy.)} = \frac{\text{Volume} \times 24 \text{ hrs./dy.}}{\text{Flow (MGD)}}
\]

\[
\frac{30000 \text{ gals.} \times 24 \text{ hrs./dy.}}{0.3 \text{ MGD}} = \frac{720000 \text{ gal. hrs.}}{300000 \text{ gals./dy.}} = 2.4 \text{ hrs.}
\]

What is the chlorination feed rate if the dosage is 12 mg/L for a flow of 2.0 MGD?

\[
\text{Feed rate (lbs./dy.)} = \text{concentration, mg/L} \times \text{flow, MGD} \times 8.34
\]

\[
12 \text{ mg/L} \times 2.0 \text{ MGD} \times 8.34 = 200 \text{ lbs./dy.}
\]

A sludge applicator applies sludge at 400 gals./min. The application path is 12 feet wide, and it runs 3 miles per hour. How many gallons of sludge are applied per acre per hour?

\[
\frac{400 \text{ gals./min.} \times 60 \text{ min.}}{4.36 \text{ ac./hr.}} = \frac{24000 \text{ gals./hr.}}{4.36 \text{ ac./hr.}} = 5505 \text{ gals./ac./hr.}
\]

What is the organic loading applied to a trickling filter with a diameter of 80 feet, a depth of 4 feet, and an influent BOD of 100 mg/L @ flow of 0.5 MGD?

\[
\text{Trickling filter organic loading (lbs./dy./1000 cu. ft. of media)} = \frac{\text{concentration, mg/L} \times \text{flow, MGD} \times 8.34}{1000 \text{ cu. ft. units of media}}
\]

\[
\text{Loading} = \frac{100 \text{ mg/L} \times 0.5 \text{ MGD} \times 8.34}{1000 \text{ Cu. Ft.}} = 417 \text{ lbs.}
\]

\[
\frac{417 \text{ lbs. BOD}}{20.1 \text{ units of 1000 Cu. Ft. media}} = 21 \text{ lbs. per 1000 Cu. Ft.}
\]

An RBC treats a flow of 1.6 MGD. Surface area is 400000 sq. ft. What's the hydraulic loading?
Hydraulic loading = Flow
Area = 1600000 gpd
400000 sq. ft. = 4 gpd/sq. ft.

BOD to an aeration tank is 125 mg/L, and the flow is 2.0 MGD. What is the F/M ratio in the activated sludge plant if the aeration tank is 500000 gallons and the MLSS is 2400 mg/L?

F/M = Food (lbs. BOD)
Mass (lbs.)
125 mg/L X 2.0 MGD X 8.34 = 2085 lbs. BOD
2400 mg/L X 0.5 MGD X 8.34 = 10008 lbs. Mass

= 0.21

Given the following information, calculate the number of pounds needed to waste to maintain a MCRT of 10 days:

Influent flow - 3.5 MGD
Aeration volume - 1.5 MG
MLSS - 3400 mg/L
Clarifier solids - 5000 lbs.
RAS - 6800 mg/L
Effluent TSS - 4 mg/L
Target MCRT - 10 days

WAS = (lbs. solids in aeration + lbs. solids in clarifier) - (lbs. solids in effluent)
MCRT

Aeration solids = 3400 mg/L X 1.5 MG X 8.34 = 42534 lbs.
Clarifier solids = 5000 lbs.
Effluent solids = 4 mg/L X 3.5 MGD X 8.34 = 117 lbs.

WAS = (42534 lbs. + 5000 lbs. ) - (117 lbs.)
10 days = 4742 lbs./dy.

The 30 minute settleometer reading is 300 ml. The MLSS is 3400 mg/L. What's the SVI?

SVI = 30 min. settling ml X 1000
MLSS, mg/L = 300 ml X 1000
3400 mg/L = 88

88
1. You apply solids on your sludge bed and it rises 1 foot the bed is 12'X10'X5'. How many gallons were applied?

   a) 600 gallons  
   b) 900 gallons  
   c) 4500 gallons  
   d) 120 gallons

Answer:

Find: cu ft

\[12 \times 10 \times 1 = 120 \text{ cu. ft.}\]

Then: Find gal/cu ft

\[120 \text{ cu ft} \times 7.5 \text{ gal/ft}^3 = 900 \text{ gal.}\]

2. A trickling filter is 60 feet in diameter with a media depth of 5 feet. What is the application rate if the influent flow is .785 MGD?

   a) 27.8 gal/sq. ft./day -  
   b) .027 gal/sq. ft./day  
   c) 277.8 gal/sq. ft./day  
   d) 27.78 gal/sq. ft./day

Answer:

Hydraulic loading = Flow to Filter (gal/day) / Sq ft of filter

Find:  

\[\frac{60 \times 60 \times .781}{2826} = 785,000 = 277.8 \text{ gal/sq ft/day}\]
5. How many gallons does the aeration tank hold if it has a total flow of 2.2 MGD and a detention time of 8 hours?

   a) 73,333 gallons  
   b) 275,000 gallons  
   X  c) 733,333 gallons  
   d) 27,500 gallons

Answer:

\[
\text{Detention time, hrs} = \frac{\text{Vol. of tank (gal)}}{\text{Inf. flow (ga1/hr)} + \text{RAS flow (ga1/hr)}}
\]

Find: \(22 \text{ MOD} = 2,200,000 \text{ ga1/day} = 91,667 \text{ gph}\)

\[
24 \text{ hrs/day} \quad \text{?} \quad = \quad 8 \text{hrs} \quad 91,667 \text{ gph}
\]

Next: \(91,667 \times 8 = 733,333 \text{ gals}\)

6. Use the data below to calculate the SVI.

MLSS = 3,500 mg/l

**Settling Test**

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Settling (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,000</td>
</tr>
<tr>
<td>15</td>
<td>450</td>
</tr>
<tr>
<td>30</td>
<td>300</td>
</tr>
<tr>
<td>60</td>
<td>270</td>
</tr>
</tbody>
</table>

a) .086  

b) 8.6  

c) .86  

X d) 8

Answer:

\[
\text{SVI} = \frac{\text{Settled sludge in 30 min (mg/l)}}{\text{MLSS (mg/l)}} \times 1,000 \text{ (mg/g)}
\]

\[
\frac{300 \text{ ml}}{3,500 \text{ mg/l}} = 0.0859 \times 1,000 = 86
\]
9. Given the data below, determine the number of pounds to waste each day if you want to maintain a 10 day MCRT.

Data: Inf. Flow = 2.2 MGD
Inf. BOD = 200 mg/l
Eff. TSS = 25 mg/l
MLSS = 3,000 mg/l
Aer. Tank = 0.8 MG
Clar Solids = 837 lbs

\[
\begin{align*}
\text{X} & \quad a) 1,626 & b) .162 \\
c) 16,260 & \quad d) 162
\end{align*}
\]

Answer: \[
\text{MCRT} = \frac{\text{lbs solids in aer. tank} + \text{lbs solids in clarifier}}{\text{days}} + \frac{\text{lbs solids wasted/day} + \text{lbs solids loss over weirs/day}}{10}
\]

\[
\begin{align*}
(3.000 \times 0.8 \times 8.34) + (837) & = 10 \\
(?) + (25 \times 2.2 \times 8.34) & = 2085 + 459 \\
20016 + 837 & = ? + 459 \\
10 & \quad 10
\end{align*}
\]

\[
\begin{align*}
2085 - 459 & = 1,626 \text{ lbs.}
\end{align*}
\]

10. An operator is asked to find the percent solids on a sludge sample. He takes a dish with an initial weight of 65.2005 g, and adds 25.0 g of wet sludge. He dries this at 1800 C for 8 hours and cools the dish. The final weight of the dish and solids is 66.2100 g. What is the percent solids of this sludge?

\[
\begin{align*}
a) .40\% & \quad b) .04\% \\
c) 4.0\% & \quad d) 40\%
\end{align*}
\]

Answer: \[
\text{% Solids} = \frac{\text{Partial Wt (mg/l) \times 100}}{\text{Total Wt (mg/l)}}
\]

\[
\begin{align*}
\frac{66.2100 \text{ g} - 65.2005 \text{ g}}{25 \text{ g}} \times 100 & = \frac{1.0095 \text{ g}}{25 \text{ g}} \times 100 = 4.0\%
\end{align*}
\]
3. You have an 8 foot deep, 100 foot diameter trickling filter that receives 875 lbs. of BOD per day. What is the organic loading?

a) 109 lbs. BOD/1000 cu. ft./day  

b) 10.9 lbs. BOD/1000 cu. ft./day  

c) 140 lbs. BOD/1000 cu. ft./day  

d) 14 lbs. BOD/1000 cu. ft./day

Organic Loading = lbs. of BOD applied/day

\[ \frac{1000 \text{ cu. ft. filter media unit}}{1000 \text{ cu. ft.-filter unit}} \]

.785 x 100 x 100 x 8 = 62,800 cu. ft. = 62.8 units @ 1000 cu. ft.-filter

1000 cu. ft.-filter unit 1000 cu. ft.-filter unit

\[ \frac{875 \text{ lbs. BOD/day}}{62.8} = 13.93 \text{ or 14 lbs. BOD/1000 cu. ft./day} \]

4. The volatile acids concentration in an anaerobic digester is 170 mg/l, the alkalinity is 3000 mg/l. What is the volatile acids/alkalinity ratio?

X  a) .06  

b) 1.7  

c) 6.0 -  

d) 16.7  

Volatile acids/alkalinity ratio = \[ \frac{\text{Volatile acids, mg/l}}{\text{Alkalinity, mg/l}} \]

\[ \frac{170 \text{ mg/l}}{3000 \text{ mg/l}} = .057 \text{ or .06 volatile acids/alkalinity ratio} \]